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Toward a 3rd Generation Sediment Dynamics Sensing System

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LONG-TERM GOALS

The central goal of this research is a deeper understanding of the dynamic adjustment of mobile sandy sediments to the variable fluid forcing the nearshore zone and inner continental shelf at small (1cm to 10m) and intermediate (10m to 100m) horizontal scales. The effort is motivated by the dual need to develop more realistic models of fluid-sediment interactions in the nearshore zone and on the continental shelf, and for suitable measurement techniques to make the observations necessary to adequately test the models.

OBJECTIVES

The objective of the proposed project is to advance the state-of-the-art of acoustic remote sensing systems for sediment and fluid dynamics studies in the wave-current bottom boundary layer. The particular focus of this project is the remote (and routine) measurement of bottom stress in energetic combined flows above mobile beds.

APPROACH

The approach involves:

- development of a new multi-frequency, broadband, several-mm vertical resolution, pulse-coherent Doppler profiler; and

- laboratory experiments in a particle-laden turbulent wall jet comparing turbulence-resolving measurements made with the new Doppler profiler to those made by Particle Imaging Velocimetry (PIV), for both hydrodynamically smooth and rough walls.

WORK COMPLETED

Funding for this project began in mid-May 2004. We held a 2-day meeting in June to review the principal design considerations for the new system. Transducers for the system prototype have been ordered. Modifications were made to the sediment-laden turbulent jet tank at Dalhousie. This tank will be used to for the combined PIV and Doppler experiments. The modifications included replacement of the Plexiglas walls with scratch-resistant acrylic. The acrylic, being both thicker and more transparent than the Plexiglas, provides a clear and distortion-free view of the laser light sheet for the PIV cameras. Modifications were also made to the jet discharge nozzle to allow us to vary the non-dimensional distance of the measurement region from the nozzle. In particular, this modification permits measurements to be made in this tank farther from the nozzle, and therefore to be more representative of fully-developed turbulence.

Work on the modeling of coherent Doppler systems has advanced. In particular, Len Zedel has developed code which simulates the effects of different complex demodulation protocols on the bandwidth requirements of the system. Programming consultant Robert Craig has begun the data acquisition coding, and electronics consultant Wesley Paul has begun the design of the signal conditioning circuitry.

Because of the major effort required to prepare for and execute the RipplesDRI component of SAX04 (see the report for N00014-04-1-0647), and the mid-May funding start, progress on this project has been slower than planned.

IMPACT/APPLICATIONS

The significance of this project resides in the fact that bottom stress over mobile beds is not well-constrained for the range of combined wave-current forcing conditions encountered in nearshore and continental shelf environments. Consequently, neither wave height decay across the shelf, nor wave-forced circulation in the nearshore and inner shelf, nor nearshore morphology change can be predicted by existing models with a high degree of confidence. New sensor systems, capable of fully resolving the vertical structure within and above the wave boundary layer, are needed to fill this knowledge gap.